

# Photographs of Water, Pilot-Test System, Membranes and Personnel Involved in Membrane Test Program



Above: Location (Drain Pit # 25) in Panoche Drainage District (near Firebaugh) where tile-drain water used in tests was obtained. (Note: Building in picture will be used for pilot plant.)



Above: 300-gallon stainless steel containers used to transport drainwater from Panoche and store it at test facility in Walnut Creek. White containers in back were used to hold NF permeate for use in RO tests.



Above: Dr. Jurgen Strasser and Dr. Karim Nafisi standing next to PCI's pilot-test system that was used in the test program.

Right top: Joe Remanda (system operator) checks feed tank as Ron Enzweiler (Project Manager) looks on.

Right bottom: Panoche drainwater in the 150-liter feed tank before start of a test. The "tinge" appearance is characteristic of agricultural drainwater.



## Photographs of Membrane Tests - page 2



Above: Drs. Strasser and Nafisi assist Mr. Remanda in setting up the pilot system for membrane test.

Above Right: Panoche drainwater (11,000 mg/ of TDS and saturated with  $\text{CaSO}_4$ ) used for tests.

Right: Results of a *non-seeded* concentration test. The buckets on floor contain permeate. The  $\text{CaSO}_4$  that precipitated out of feed at 4x concentration is visible in bottom of feed tank.

Below left: Dr. Nafisi adds  $\text{CaSO}_4$  seed crystals to feed tank before starting seeding test. Pneumatic mixer was used to keep seed crystals in suspension in feed tank.

Below right: Feed tank before start of a seeded test.

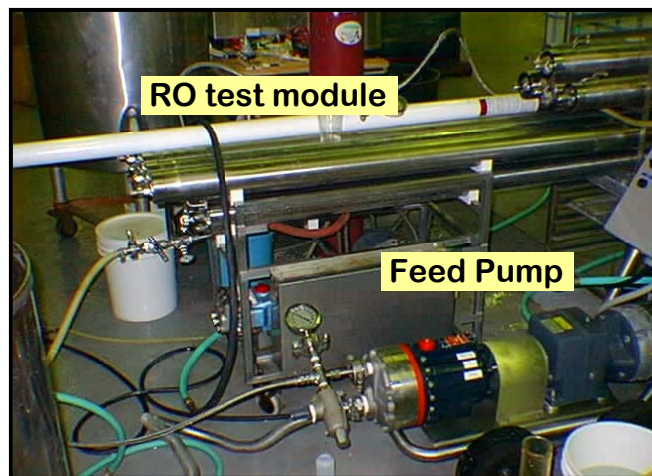
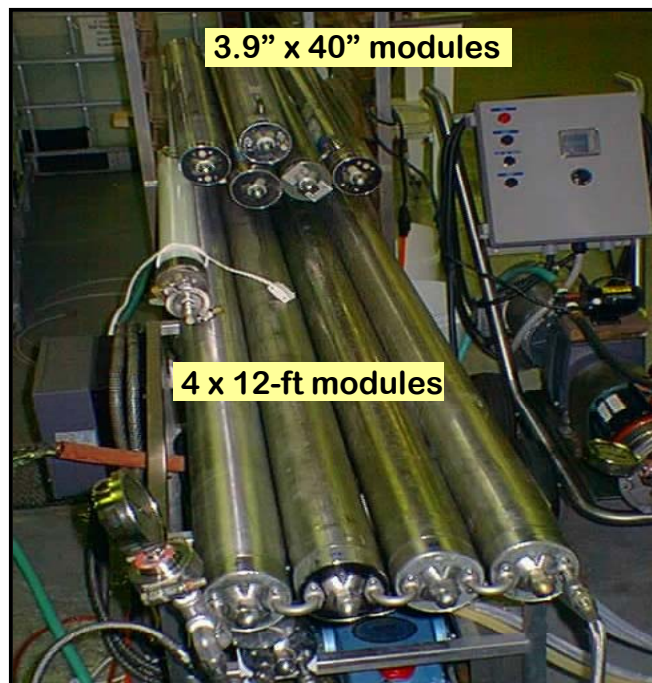




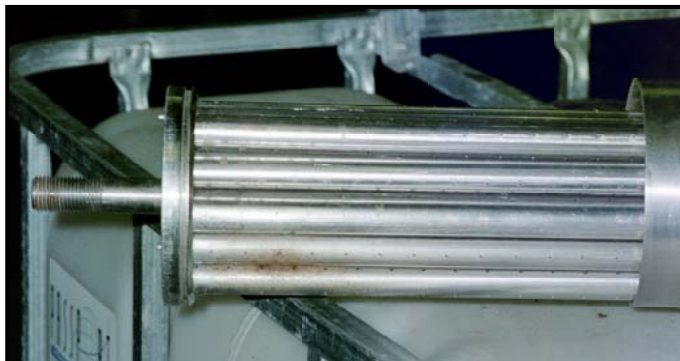
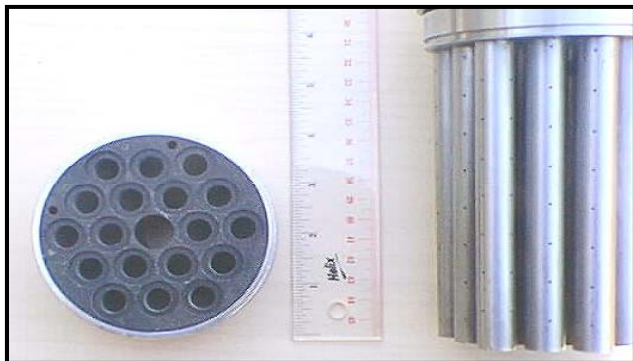
Top: Appearance of feed tank at beginning of seeded concentration test (left) and after 5x concentration at end of test (right)

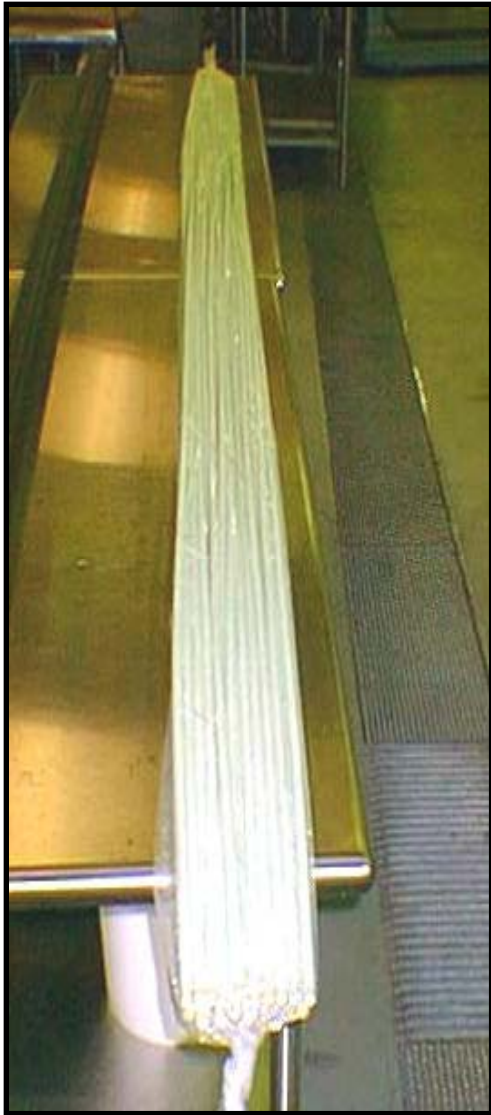
Right: Results from dye test performed to check integrity of 4 x 12-ft. AFC30 modules. The bucket on far left is the concentration. The four other buckets contain the permeate from each individual module. The dye is a proxy for TDS. **This test demonstrates how membranes work.** At a constant operating pressure, the rate of movement of *water* (flux rate) through the four modules in series *decreases* as the feed TDS level (and thus feed osmotic pressure) *increases*; however, dissolved *salts* pass at a constant rate through the membrane since salt passage is independent of pressure. Thus, the *permeate TDS level increases* (as shown by the progressively darker colors) from module #1 to module #4.





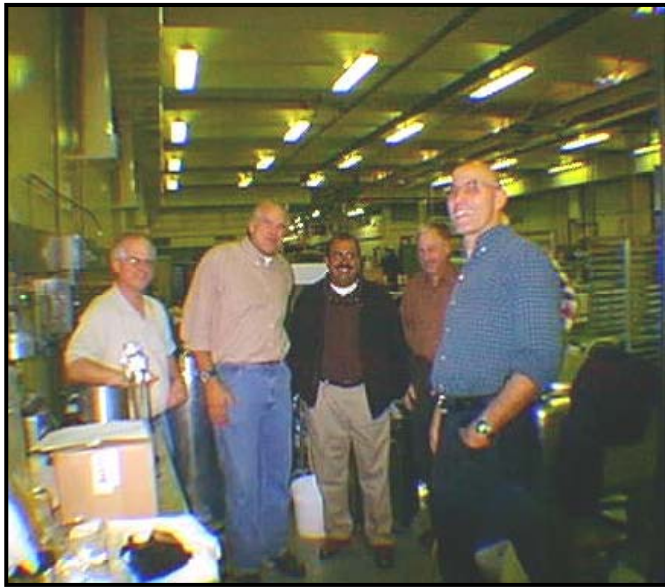
Below: Internal parts of PCI tubular membrane modules. Each 3.9" module contains 18 - ½" diameter tube-holders connected in series (connectors not shown). Replaceable membrane inserts (not shown) are placed inside the perforated tube-holders. The pressurized feed flows *inside* each tube. Permeate trickles out the holes in the tube-holders and collects in the module housing which has a discharge port. (Note: Plastic components [not stainless steel as shown] will be used in commercial DP<sup>3</sup>RO™ plants.)





Top Left: Set of 18 – ½ inch diameter x 12 feet long AFC30 membrane elements for insertion into one (1) 3.9" x 12-ft module. All 18 of these 12-ft. tubes were connected in series in each module; and all four 12-ft. modules were connected in series. This provided the equivalent membrane tube length (864 ft.) as contained in one (1) 8" x 12-ft commercial module with 72 tubes. Close-up of end of membrane inserts is shown on left.

Top Right: The four (4) 2.5" x 40" spiral-wound RO membranes that were tested.



Above Left: (left to right) Peter Allan (PCI Membrane Systems), Ron Enzweiler (Project Manager) with David Lara, Kurt Kovac and Jose Faria from DWR at the WCRC on December 11, 2002



Above Right: (left to right) Saied Delagah, Alan Stroppini, and Scott Irvine from USBR at the WCRC on December 19, 2002. This visit was part of Reconnaissance Visit to San Joaquin Valley sites for USBR's In-Valley Alternative Feasibility Study

Below: Dr. Jurgen Strasser (left), Membrane Test Program Director, and Dr. Karim Nafisi (right) Research Chemist. Drs. Strasser and Nafisi provided over 100 in-kind service hours on the project.

